GOLDENSEAL

UNDER CULTIVATION

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GOLDENSEAL is regarded as a minor money crop and is well adapted for growers who can take care of the special requirements of the plant. It makes its chief appeal, however, to ginseng growers, who already are equipped for growing exacting woodland plants and find in goldenseal a good side crop.

Assuming a possible yield of 1 ton of dry root to the acre and an average of 4 years for the root to mature from seed or root propagation, not more than 500 acres would be needed to produce the 100 tons or less of dried root that is the estimated annual consumption. Over-production has doubtless been responsible for the small returns obtained in some years. Prospective growers should bear in mind the commercial limitations of a crop of this character.

Before starting a bed of goldenseal, the amateur should study the methods adopted by those who have been successful in growing ginseng and plan his equipment accordingly. Goldenseal requires essentially the same conditions as ginseng, but it is generally regarded as a less difficult crop to grow.

This bulletin is of interest to residents of the Eastern, North Central, and North Pacific Coast States.

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GOLDENSEAL UNDER CULTIVATION

By A. F. SIEVERS, *principal biochemist, Division of Tobacco, Medicinal, and Special Crops, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration*[1]

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DESCRIPTION OF THE GOLDENSEAL PLANT

GOLDENSEAL, known botanically as *Hydrastis canadensis*, is a perennial, with a short, yellow rootstock prominently marked with seallike depressions caused by the falling away of the annual stems. A great many popular names have been given the plant in the past, but goldenseal and hydrastis are now most commonly used.

The stems of goldenseal grow a foot or more in height and bear two (or rarely three) large, slightly hairy, five-parted leaves. The stems are purplish and hairy above the ground, but below the soil surface they are yellow, like the roots.

In early May, before the leaves are fully developed, a single, small, greenish-white flower appears on a short branch, or rather on the continuation of the stem above the upper leaf. This flower develops into a berrylike fruiting head, bright red in color when fully ripe, and resembling a large raspberry. Each fruit may contain from 10 to 30 black seeds, somewhat smaller than buckwheat grains. Several stems are commonly sent up by the stronger rootstocks, but as a rule only one flower head is developed. In old clumps, as well as on young and weak plants, there are many stems that bear a single leaf but no flower. The stems and leaves usually die down soon after the fruit ripens, but in moist seasons favorable to late growth they may persist until frost. Winter buds, generally two in number, form near the base of each stem. These buds perpetuate the growth next season, but as a rule only one bud starts in the spring, the others acting as a reserve in case of accident.

[1] The late Walter Van Fleet, physiologist, Drug-Plant and Poisonous-Plant Investigations, Bureau of Plant Industry, was the author of the original of this bulletin, which was issued in 1914.

The fresh rootstock is rarely more than 2 inches in length and is about three-fourths of an inch in thickness, giving forth at the sides a large number of fibrous yellow roots a foot or more in length (fig. 1). It contains a considerable quantity of yellow juice, rather rank in odor, which was formerly used as a dye. When dried, the rootstock shrinks to about one-fourth of an inch in diameter and becomes hard, knotty, and wrinkled. The dried rootlets are very brittle and break away from the rootstock unless carefully handled. This "fiber," as it is commercially termed, has medicinal value equal to that of the rootstock but brings only about half the price when separated from it.

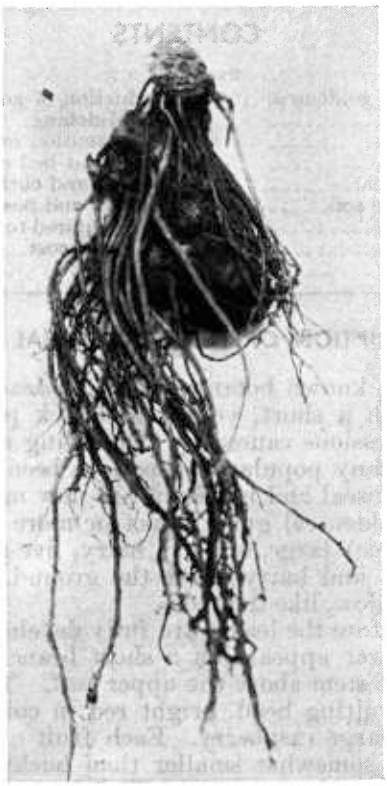


Figure 1.—Mature root of goldenseal.

HABITAT AND RANGE

Goldenseal is native to open woodlands where there is ample shade, good natural drainage, and an abundance of leafmold. Its range is from southern New York and Ontario west to Minnesota and south to Georgia and Kentucky, ascending to higher altitudes as its southern limits are approached. The most abundant centers of distribution are in Ohio, Indiana, West Virginia, and Kentucky.

In its natural situations goldenseal often grows in dense patches of considerable area, spreading through the loose mold by means of root

buds which form irregularly on the long fibrous roots that penetrate the soil in all directions, the growth following chiefly the lines of least resistance, as, for example, along the sides of decayed fallen trees or in the spaces between loose rocks (fig. 2). The rootstocks, too, decay with age and break up into several growing points, which eventually form independent plants.

COMMERCIAL HISTORY

Until about the year 1880 the price paid for crude goldenseal was rarely more than 8 to 12 cents a pound, the price, as a matter of course, being based on the actual cost of collecting and curing the material in the localities where it was most abundant. In 1890, however, the approaching scarcity of the root was manifested by rising prices, and

Figure 2.—Goldenseal in forest growth, 4 years old.

at the close of the next decade the cost had advanced to an average of 58 cents a pound. Early in 1904 the price passed the dollar mark, the year closing with wholesale quotations ranging from $1.35 to $1.50 a pound. Thereafter, with the exception of slightly lower prices in 1912, which were apparently the direct result of overcollection, there was a steady advance in the price of the dried root, both wild and cultivated, until 1920, when its market value exceeded $6 a pound. Following this, a decline set in for a few years, lasting until 1924, when the lowest quotation was $2.50 a pound. For several years thereafter the market improved somewhat, the best quality of root bringing up to $4.50, until 1928, when a steady decline began, which continued until 1932, when the prevailing price dropped below $1 a pound. This condition prevailed for some time, but there was some recovery after 1935 and in the following 10 years the wholesale quotations ranged from $3.50 to $5 a pound.

For some time the wild root has been so scarce throughout the greater part of its range that it now is not an important factor in the market. Natural reproduction is slow, even under the most favorable conditions, and the plants are unable to grow where more vigorous vegetation invades forest lands that have been cleared. As collections of the plant declined there was a gradual increase in its cultivation. Statistics on the quantity of root produced under cultivation are not available from year to year. According to the Census of Agriculture of 1940, the production in 1939 was 15,144 pounds, valued at $40,464, obtained from about 50 acres. More than half of this production was in Washington. Oregon, Wisconsin, Michigan, and Tennessee together furnished about one-third of the total. There have been no reports on production since 1939.

The herb (leaves and stems) is also handled in the crude-drug trade, but it usually is of low market value. Quotations have ranged from 15 to 85 cents a pound. It has not been generally quoted in recent years.

PRODUCTION OF GOLDENSEAL

In commerce and in culture goldenseal is closely associated with native ginseng, as both grow in similar locations and long have been collected by the same drug-root hunters. When the cultivation of goldenseal began about 45 years ago, it was naturally taken up by the ginseng growers, who were well informed concerning the needs of woodland plants. Although the cultural requirements of goldenseal are very similar to those of ginseng, goldenseal appeared at first to be the less difficult plant to grow. The seeds, when properly treated, grow the following season, and the roots are rarely injured by mice, which sometimes cause considerable damage to ginseng. When first placed under cultivation the plant was far less subject to disease than ginseng, but with continued cultivation diseases have become a very serious problem for the growers. As compared with ordinary garden crops, goldenseal is not an easy plant to grow, as it requires special care and suitable conditions at all stages of its development.

PREPARATION OF THE SOIL

The soil should be well fertilized, preferably by the use of decaying vegetable matter such as woods soil and rotting forest leaves, which should be well worked in to a depth of 10 inches or more. Raw bonemeal and cottonseed meal are favorable in their action and have also the great advantage of not introducing weed seeds. Both may be applied at the rate of half a pound to each square yard of bed surface, or something more than 1 ton to the acre. The best means of supplying the indispensable element, potash, appears to be by using the sulfate at the rate of 2 ounces to the square yard, or 600 pounds per acre. Acid phosphate, or dissolved rock, and the various commercial fertilizer mixtures containing it do not appear to suit goldenseal, nor do wood ashes, probably on account of the neutralizing effect of their lime content. These fertilizers—leafmold, bonemeal, cottonseed meal, and sulfate of potash—should, if possible, be well mixed with the soil 2 weeks or more before setting the plants. If needed, smaller quan-

tities may be applied subsequently as top dressings and lightly worked in.

Thoroughly rotted stable manure applied in early spring as a mulch or incorporated into the soil before planting greatly stimulates growth, but sometimes it appears to favor the decay of the crowns and frequently introduces troublesome weeds. For these reasons it is little used by the more experienced growers.

If the soil is of close texture, leafmold should be used with great liberality; a covering 4 inches deep, with an additional inch or two of sand, is not too much to incorporate when preparing the beds.

For seedbed purposes sufficient sand and leafmold should be used to prevent baking after heavy rains, but it is best to omit all other fertilizing material. Seedbeds need not be worked deeper than 6 inches, as it is not desirable to have them settle to any great extent.

Plant beds should be formed sufficiently high in the center to shed rain, but it is perhaps not well to make them extremely convex for the purpose of gaining greater planting surface, as the steep slopes dry out too rapidly. Plants may be set 6 to 8 inches apart each way, the rootstocks being set about 2 inches deep. Seedlings and root cuttings may be set 3 inches apart at first and afforded greater space when next transplanted.

PROPAGATION

Goldenseal is propagated by means of seeds, by division of the rootstocks at the dormant period, and by buds or young plants formed from the stronger fibrous roots. Of the three methods, division of the rootstock is perhaps the one most frequently used, as two or more buds usually form near the scar left by the stem when the top decays after the summer's growth. It is only necessary to cut apart the rootstock, taking care that a few good roots are obtained with each bud or growing point. The parts of the rootstocks with the accompanying rootlets that do not possess buds, or "eyes," may be dried for market. It is the usual practice when digging beds of cultivated goldenseal or when handling the fresh wild root to use for replanting all buds that can be spared from the drying stock. From rootstocks of marketable age an increase of 200 to 300 percent of propagating material may thus usually be had and a fair surplus of root left for drying. When used for purposes of propagation only, the beds may be dug over each year and the rootstocks divided, an increase of about 100 percent being thus obtained under favorable conditions.

Root-Bud Propagation

The buds and plants that form on the stronger fibrous roots are very irregularly distributed and occur from 2 inches to a foot from the rootstock. Naturally they are most abundant on the roots of plants that have not been disturbed for several years and that in time form the matted growths that are found in undisturbed wild colonies and in old beds under cultivation. These plants are usually quite small but may be half an inch or more in height. The larger ones may be planted with the main crop, while the smaller ones are best set under shade, about 3 inches apart. They may be placed in boxes or in

beds of prepared light soil with a good proportion of leafmold, where they may be allowed to grow until large enough to transplant to the regular beds. The plants should be dibbled in, with the growing point an inch or so below the surface. Under ordinary conditions the yield from root buds should add from 50 to 75 percent of the annual increase. These buds are often quite obscure in form, but practically any healthy thickening on a goldenseal root may be expected to produce a plant if given a fair chance.

Propagation by Seed

The earlier goldenseal growers did not greatly favor propagation by seed, which had to be obtained from wild plants. It was usually scarce, owing to the dense growth of many of the wild stands and the frequent destruction of the ripening berries by birds and forest animals. The seed when gathered was often allowed to become dry before it was planted, or it became injured by too-rapid fermentation of the fleshy coatings if stratified with a scant amount of sand or similar inert material. Plantings in forest seedbeds appeared to give poor results, owing to various disturbing causes, even when the seed was in good condition. Under cultivation, however, seed is freely produced, owing to the better spacing of the plants and its security from birds and animals. If properly handled, seed should germinate with vigor the following spring, or earlier if sown under glass.

The berries, or seed heads, should be picked as soon as they begin to show color, and when a sufficient quantity has been obtained it is probably best to knead them in a bag or run them through a fruit squeezer so as not to crush the seed and thus get rid of the fermentable materials in the juice and pulp. The residue, consisting of the skins and seed, may be mixed with 10 times its bulk of sand or sifted woods soil and stratified in well-drained pots or boxes. These should be covered with fine wire netting, to exclude vermin, and kept in a cool, moist cellar or buried in the soil in a shady place free from standing water. The soft parts soon rot away, leaving the seed in its naturally moist condition, fresh, plump, and bright.

The seed may be sown in October in a well-prepared seedbed containing a large proportion of sifted woods soil worked in to a depth of 6 inches. It may be scattered broadcast with the stratifying material or sifted out and dropped one-half inch apart in rows about 6 inches apart. The seed should then be pressed into the moist soil with the flat side or edge of a board and covered with fine leafmold to the depth of an inch. Burlap or old fertilizer sacks make a very good winter covering for the beds, keeping in the moisture and protecting the seed from being washed out by the drip from boughs, or from laths, if under an artificial shade. A mulch of leaves or moss may be placed over the burlap during frosty weather to lessen the danger of heaving. Seedbeds should be especially well protected by means of pieces of roof slate, boards, or wire netting set deep into the ground against the encroachment of moles or mice. They should also be protected against trampling, as the sprouting seed is readily injured by such disturbance.

Should the quantity of seed gathered at any one time appear too small for pressing, the berries may be partially dried and stratified

with a large quantity of nearly dry soil or sand. In this way intense fermentation that may occur when the fresh fruits are stratified with only a small quantity of inert material is avoided. On no account should the seed be allowed to become entirely dry, as it will then probably fail to germinate, even under the best conditions. When stratified, the half-dried berries or seed should be disposed in alternate layers with sand or mold, the layer of mold being much the thicker. The receptacles should occasionally be examined to ascertain whether the contents are likely to dry out.

When goldenseal seed is sown in the open, whether under lath shade or in the forest seedbed, during the first season the seedlings rarely get beyond the seed-leaf stage, the true leaves appearing the following spring (fig. 3). If, however, the seed is planted under glass at the beginning of the year and has night temperatures of about 55° F., with a proportionate rise during the day, and adequate shade in the following summer, sufficient progress may be made by the close of the season to develop good-sized leaves, with rootstocks large enough to plant out in the beds.

In the experiments of the United States Department of Agriculture there have been grown in a single 10-inch pot, in 10 months, as many as 50 vigorous seedlings (fig. 4), with from 1 to 3 buds to a single rootstock and with roots more than a foot in length (fig. 5). These seedlings were grown from properly stratified seed that was collected in August and sown the first week in the following January in a compost of equal parts of leafmold and loamy garden soil.

Low greenhouses, such as are used for growing ordinary vegetable plants in midwinter and early spring, would afford congenial conditions for goldenseal. Since greenhouses of this type may be built at moderate cost, it may be questioned whether such glass protection for the seedlings would not be a real economy, considering the saving in time and the gain in vigor of the plants.

When collected in small quantities, the fresh berries may be broken apart and at once planted in pots or seedbeds, or the seed may be washed out and immediately planted, but the results are rarely as good as when the seed is stratified. On no account should the berries be planted whole, as the seedlings, if they come up well, will be too crowded for satisfactory development.

SHADE

When well established in favorable soil, goldenseal will endure nearly full sunlight, but for satisfactory growth it requires about 75 percent of shade in summer, though much less will answer in spring. In other words, three-fourths of the sun's rays should be excluded in summer, either by forest shade or by structures of convenient height covered with laths, cloth, brush, or vines sufficient for the purpose. In northern sections less shade is thought necessary than in southern localities. Such structures should be covered on top and on the south and west sides with brush, boards, or laths spaced so as to exclude about three-fourths of the sunlight. They should be open to the east and north in order to permit the greatest amount of ventilation. Very heavy burlap has been used with fair success for shading woodland plants, but thin or ordinary muslins

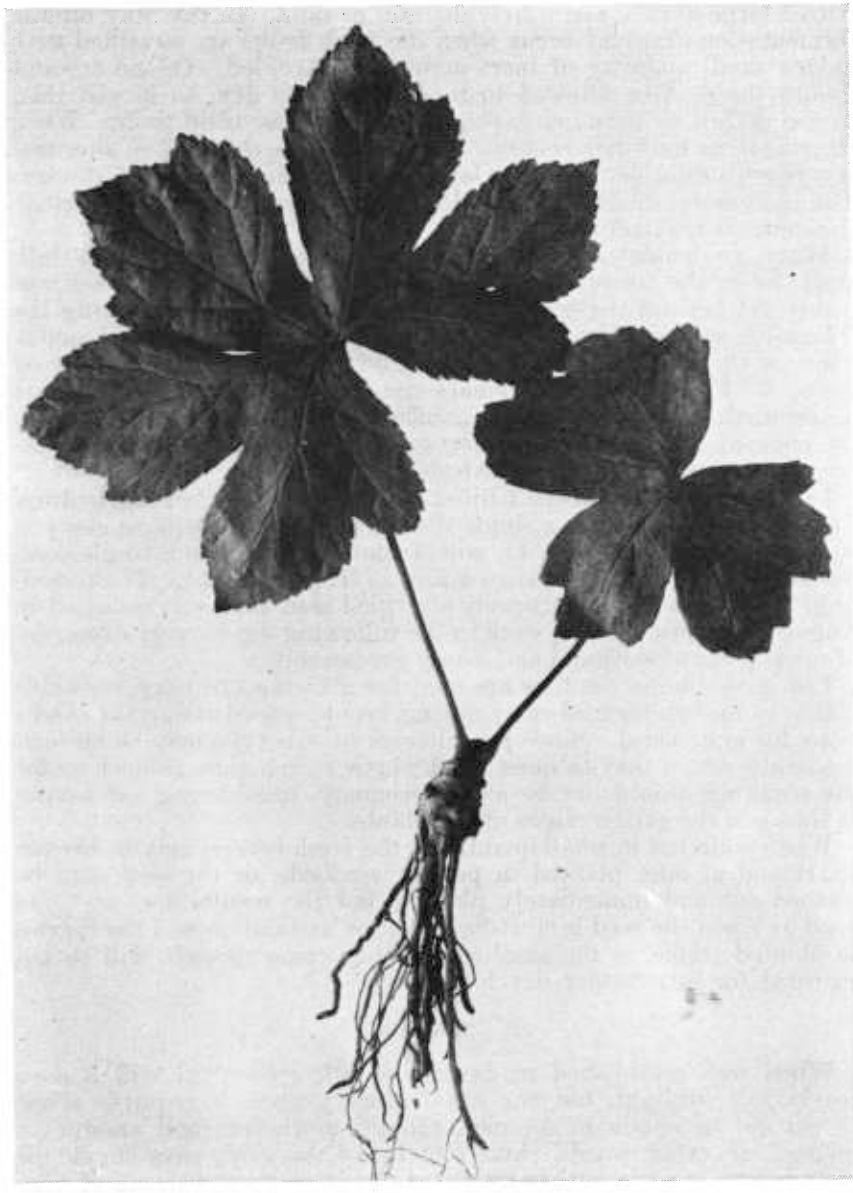


Figure 3.—Goldenseal plant grown under a lath shed, second year.

do not intercept enough light, while they frequently appear to retain heat to an injurious degree. In the North, where open construction is preferred, use can be made of grapevines, lima beans, or morning-glories, which may be planted on the south and west sides and allowed to run on wire netting, thus furnishing shade during the bright summer months; but the grapes at least should stand at some

Figure 4.—Goldenseal seedlings grown under glass, 5 months from sowing.

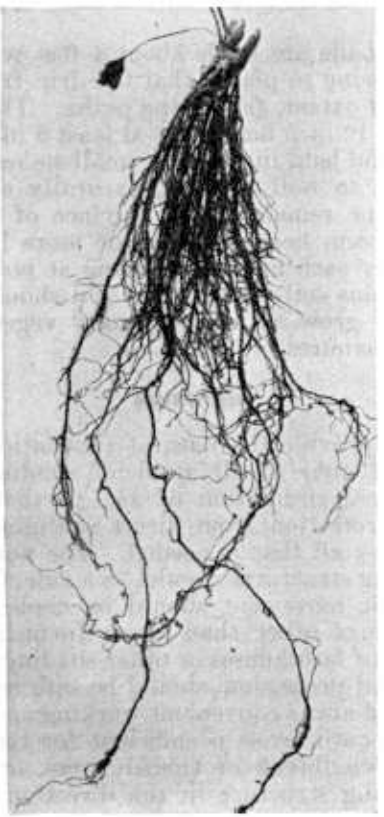


Figure 5.—Pot-grown root of goldenseal, 10 months old.

distance from the arbor, in order that the feeding roots may not interfere with the goldenseal.

There are many methods of obtaining the necessary shade, the most common being to set posts of durable wood firmly in the ground 8 feet apart each way, rising about 7 feet above the soil surface. Scantlings 2 by 4 inches in size are nailed on top of the posts, running the long way of the shed. The shade is usually provided in sections 4 by 8 feet long, using common 4-foot laths or slats nailed on strips 2 by 2 inches and 8 feet long. The laths should be spaced from one-fourth to one-half inch apart, according to whether the locality is in the North or in the South. These sections of the shading structure are laid on top of the 2- by 4-inch runners and are so nailed or tied to the posts that the laths run nearly north and south, thus giving the plants below the benefit of constantly alternating light and shade. When the sections are wired or tied instead of being nailed fast to the runners, they may be taken off and stored during the winter, thus adding greatly to their durability and avoiding damage to the sheds from heavy snowfalls.

For covering the seedbeds a rather low shade is desirable, in order to prevent the washing out of the seeds by the drip from the laths. Poultry netting covered with brush, straw, litter, or burlap—just a little in the spring and more as the sun grows hotter—answers the purpose very well.

The beds under shade are made about 4 feet wide and preferably run east and west, being so placed that the drip from the ends of the laths will, to a great extent, fall in the paths. The sides of the beds are usually made of 12-inch boards set at least 8 inches in the ground, to keep out moles, and held in place by small stakes. The soil should be fairly light and so well drained, naturally or artificially, that water can at no time remain on the surface of the beds. Should artificial drainage seem necessary, one or more lines of small tiles may be placed under each bed, discharging at points low enough to carry away all surplus soil water. The soil should be in good tilth and rich enough to grow at least ordinary vegetables without the addition of strong manures.

VENTILATION

Forest plantings provide the natural ventilation that is required by the goldenseal plant; in all artificial shading provision must be made for the free circulation of air, particularly in moist or cloudy weather. Protection from direct sunlight overhead and on the south and west is all that is needed. The northern and eastern aspects of all shading structures should, as a rule, be open, and whenever possible the air movement should be unobstructed by nearby buildings or plantings other than those furnishing the necessary shade. The height of lath houses or other shading appliances, except in the case of seedbed protection, should be sufficient to allow a good circulation of air and also a convenient working space. Seven feet of clearance above the path levels is sufficient for the purpose. In exposed situations a windbreak of timber, trees, or shrubbery a few feet from the shading structure in the direction of the prevailing

windstorms may be of great service in preventing damage to the tender growth without greatly reducing the ventilation requirements.

MULCHING

Summer mulches of well-rotted hickory, maple, or basswood sawdust are especially favorable for seedbeds and young plants, as such materials greatly conserve the soil moisture and prevent much weed growth. Sawdust from pine or oak is not considered desirable. Of more importance, however, is the winter mulch of leaves, bean vines, cowpea hay, or other coarse litter not containing weed seeds or material attractive to mice, as it lessens heaving and the undue frosting of the crowns, and as a protection from the drying winter winds it is quite in accordance with the natural woodland conditions. Winter mulches are particularly necessary for seedbeds, 4 or 5 inches of leaves or their equivalent in litter being ample for the severest climates, while less is needed in the South. As a rule, the material need not be placed in position until actual freezing is imminent and should be removed in the spring before the first shoots come through the soil.

ATTENTION REQUIRED

Aside from having the beds kept free from weeds and other interfering vegetation at all times during the growing season, goldenseal needs little attention. If loose mulches of such fine materials as old sawdust are used they may be allowed to remain during the summer and will go far toward suppressing weed growth. If the mulch is thin and the soil shows signs of crusting during dry weather, the earth may be lightly stirred with a suitable tool, but deep culture at any time is likely to do more harm than good by breaking up the mat of fibrous roots that run near the surface.

Goldenseal has a relatively short growing season, and its growth may be seriously checked by untimely droughts. Liberal applications of water at such critical times—applying enough at once to soak the beds thoroughly—may make the difference between partial failure and a successful season's growth. Growers of goldenseal may well consider the advantages of dry-weather irrigation where it appears to be practicable.

FOREST-BED CULTURE

After passing the seedling stage, goldenseal is well adapted to forest culture, as the plants are not preyed upon by wood mice, which so often work serious havoc with the tuberous roots of ginseng. The location selected should have good drainage, as the plants, though fond of moisture, do not thrive in boggy ground. It should be well shaded by tall trees rather than by undergrowth. Oak, maple, sycamore, and basswood afford very suitable shade; but pine, spruce, hemlock, and similar trees should be avoided.

The plot should be deeply plowed or spaded, and all tree roots removed to the depth of a foot or more. New root growth may be reduced by cutting around the beds each year with a sharp spade. In addition to the natural coatings, a liberal dressing of leafmold or well-decayed litter should be worked deep into the soil. It is well also

to rake in bonemeal and sulphate of potash at the rate of 10 and 4 pounds, respectively, to the square rod when finishing off the beds. The plants should be set in the same manner and at the same distance apart as those under artificial shade.

Except that forest beds require more frequent supplies of plant food and water on account of the competition of tree roots, cultural treatment is in all respects similar to lath-shed plantings, even including the winter mulch of fallen leaves if it is not sufficiently supplied by nature.

DIGGING AND CURING

The roots may be dug at any time in the autumn after the tops have died down. It is best to take up the beds solidly when of sufficient age, as the root buds and small plants are generally abundant enough to reset if it is thought desirable.

The rootstocks and attached rootlets are washed clean of all soil and freed from sticks, pebbles, or other foreign matter lodged in the fibrous masses. All buds and divisions needed for further propagation should be removed before they become dry. The rootstocks are conveniently dried on lath screens in an airy place in mild sun or partial shade, or indoors on a large, clean, dry floor. They should be turned several times daily until thoroughly dried. When dried in the open, they should be protected from dew at night and taken under cover on the approach of rain. In very dull weather it may be well to finish the drying in a heated room with a temperature of about 80° F.

The cured root is best kept in rather loose masses in a dry, airy place free from vermin until ready for market. If closely packed while at all moist it may be attacked by mold, which greatly lessens its value. Thoroughly dry root may be shipped safely if tightly packed in bags or boxes, or in barrels well lined with paper.

The market for goldenseal root is found with crude-drug dealers and manufacturers of medicines. Goldenseal root is also handled on commission and is readily purchased by fur buyers and traders in miscellaneous forest products.

DISEASES AND PESTS

Of the several diseases occurring on this plant, the most common and destructive is botrytis blight. This disease is prevalent in New York, Ohio, Michigan, Indiana, and Wisconsin, and has been reported in North Carolina and in the Puget Sound area in Washington. It is noticeably destructive only in wet seasons, when at times it kills 10 to 20 percent of the tops. All parts of the plant are attacked, including rootstocks, leaves, blossoms, and seed heads. Seedlings are often destroyed. The blighting of the leaves and the rotting of the petioles at the base are the symptoms most commonly observed. Bordeaux mixture and other standard fungicides give partial protection, but cannot be relied upon for complete control, particularly in wet seasons. As an additional measure infected beds in the fall of the year should be cleared of all mulching material in which the fungus is able to carry over, together with the tops of the plants themselves. If the disease has been severe, copper sulfate solution at the rate of 1 pound

to 10 gallons of water might be sprayed over the beds before the mulch is replaced. All diseased material should be burned or removed to a considerable distance from the garden.

Other diseases are of minor importance, and measures adopted to control botrytis blight will ordinarily hold them in check sufficiently well. Careful attention to the suggestions given in this bulletin for proper shading, ventilation, mulching, and other cultural requirements will do much to prevent loss from fungus diseases.

The roots of goldenseal are subject to root gall, and the plant cannot therefore be safely used as a succession crop for ginseng beds that are infected with the gall.

Slugs and earthworms disturb the seedlings, the slugs eating the crowns down to the rootstocks. Moles also may cause loss by upheaving the beds. Cautious applications of lime will reduce the annoyance from worms and slugs, but the best means of controlling slugs is to pick them off by hand at night with the aid of a lantern. The moles may be trapped, or, better, may be kept out entirely by bordering the beds with slates, boards, or fine wire netting set 8 inches or more in the ground.

TIME REQUIRED TO PRODUCE A CROP

Under favorable cultural conditions goldenseal reaches its best development for market in about 5 years from the germination of the seeds, or a year or two less when grown from root buds or by division of the rootstock. After the fourth year decay of the center or of the older parts of the rootstock may set in, thus offsetting the natural increase in size and weight.

YIELD AND COST

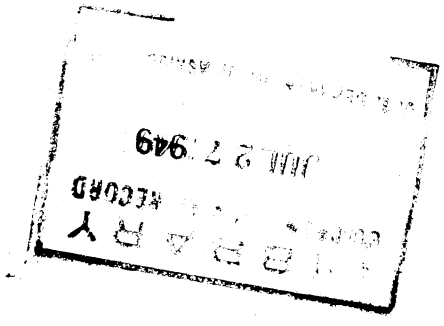
Reliable information regarding the yield of roots that may be expected from an acre of goldenseal is not generally available. Experiments [2] on small plots under lath shade gave yields at the rate of about 5,000 pounds of green root to the acre, representing nearly 1,500 pounds of dried root. The conditions at this place, however, were far from ideal for forest-loving plants. Successful growers of goldenseal have outputs of dry root at the rate of 2,000 pounds per acre at 5 years from seed. Possibly such yields may not be greatly exceeded in large plantings, but well-equipped small growers who can give their crops special attention may make much better showings.

The cost of goldenseal culture is largely controlled by special conditions, the chief of which are the local costs of labor, lumber, and fertilizing materials. Up to about 1935 it was estimated that the outlay for starting the planting was about $1,500 per acre, exclusive of the value of the land. This included the average cost for propagating material, but made no provision for irrigation or watering during dry

[2] These experiments were conducted by the former Office of Drug-Plant and Poisonous-Plant Investigations, Bureau of Plant Industry, in 1908-13 at the Arlington Experiment Farm, near Rosslyn, Va. Work at this farm was discontinued in 1942.

weather. At that time the preparation of the forest beds usually represented an outlay approaching $200 per acre, with such additional expenses as might be necessary for protection, fertilization, and irrigation, as the live tree roots are greedy absorbers of plant food and water and always appropriate a considerable share of the fertilizers applied. With the much higher costs of labor and materials at the present time it would of course require a much greater outlay to accomplish the same things.

Small home and experimental plantings usually may be initiated with very little expenditure of money, but cultivation on a large scale requires a considerable outlay.



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